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OPERATION OF THE VGD SYSTEM AT THE IRBITSKII GLASS WORKS

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The use of a method for controlling the FeO content in a glass melt and maintaining the optimum ratio of FeO : Fe_2O_3 makes it possible to stabilize the density and quality of the glass, even in rapid changeovers from one type of material to another.

The leading role in the thermal balance of glass-melting furnaces is played by radiation heat conduction which depends on the radiation absorption coefficient and the wave length of the light passing through the glass melt.

The radiation heat conduction varies little with variations in the glass composition and is usually determined by the content of FeO. With a substantial content of FeO and a high ratio of FeO : Fe_2O_3, a significant temperature gradient develops in the glass melt and impedes heat transmission to the deep layers of the tank. We established that the course of the FeO $\rightleftarrows$ Fe_2O_3 reaction is mainly determined by the effect of the redox conditions of the glass-melting process, which in turn depend on the composition of the raw materials in the mixture. In order to attain the prescribed values in the reaction formally expressed by the equation:

$$Fe^{3+} + O^{2-} \overset{\Phi}{\rightleftarrows} Fe^{2-} + O_2 ,$$

where Φ is the factor regulating this equilibrium, the redox potential of the mixture is corrected taking into account the value of the FeO content. Taking into account the prescribed values of the temperature of the cooling zone bottom and the glass melt in the maximum zone, we found that the optimum ratio of FeO : Fe_2O_3 should be within the limits of 20 – 30%.

The vertical glass drawing (VGD) system at the Irbitskii Glass Works was stopped for a scheduled cold repair in April 1994. Since at that time the factory was in a difficult financial position, a decision to implement partial repair of the tank furnace was adopted. The elements that were not replaced include the melting tank enclosure, suspended walls, main roof (from the third pair of burners to the working flue), the cooling zone with the floating screen, and the working flue. The maximum degree of corrosion of the floating screen beams in the center was 160 mm from initial immersion into glass melt (380 mm).

The tank furnace resumed operation in November 1994. At the same time dolomite from the Melekhovo-Fedotovskoe deposit was replaced by local dolomite from the Bilimbaevskoe deposit. It should be noted that the use of fuel oil delivered by different suppliers (from Omsk, Perm', Ufa) complicated the glass-melting conditions.

It would be impossible to provide for subsequent operation of the tank furnace in 1996 – 1997 as the corrosion of its structural elements increased, to ensure the required optical parameters of the glass, and to provide for reliable operation of VDG machines manufacturing glass 3, 4, 5, and 6 mm thick, were it not for daily control of the FeO content in glass performed for all machines and maintaining the FeO : Fe_2O_3 ratio at the optimum level.

The operating parameters of the VGD system from the moment of its start-up are shown in the Table.

The use of the method for checking the FeO content in the glass melt made it possible to stabilize the glass density within the limits of 2.4965 ± 0.0035 g/cm^3, whereas the daily deviations in density did not exceed ± 0.0005 g/cm^3. Compared to previous years, the residual stresses in glass annealing approached the prescribed norm of 5 – 15 nm · cm/mm (TTR 21-21-01–86). The actual value of this parameter in 1995 was 10 – 23 (in May it was 17 – 30), in 1996 was 10 – 13, and in 1997 was 8 – 10 nm · cm/mm.

The average values of the glass radiation coefficient (GRC) in the previous periods amounted to 0.72 in 1982 – 1985, 0.74 in 1986 – 1989, and 0.72 in 1990 – 1993.

It should be noted that in the period when the above method was used in the second half of 1995 and 1996 – 1997, the VGD machines functioned reliably even in cases of

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TABLE 1

Date	Average value (instrument readings), %			Average temperature, °C		Average value of GRC
	FeO	FeO : Fe_2O_3	Fe_2O_{3tot}	of the bulb	of the cooling zone bottom	
12.05.94*	0.038	33	0.157	941	1116	
12.19.94*	0.033	30	0.146	944	1131	0.75
12.26.94*	0.033	30	0.147	932	1127	
04.24.95	0.039	34	0.152	905	1115	0.73
05.08.95	0.043	39	0.157	916	1109	
05.15.95	0.041	38	0.153	915	1115	0.54
05.23.95	0.032	25	0.163	934	1140	
05.29.95	0.026	27	0.153	939	1144	
12.07.95	0.027	29	0.150	948	1133	
12.18.95	0.024	27	0.141	950	1141	0.80
12.28.95	0.022	25	0.137	955	1150	
1996						
February	0.023	28	0.141	948	1149	0.85
May	0.020	24	0.137	947	1158	0.81
August	0.022	24	0.155	947	1160	0.82
October	0.022	24	0.148	949	1149	0.85
1997						
February	0.020	23	0.143	951	1150	0.81
May	0.023	26	0.148	940	1145	0.82
June	0.020	25	0.137	932	1153	0.75**
August	5.021	25	0.141	951	1162	0.84
November	0.021	24	0.142	951	1159	0.84
December	0.022	23	0.153	947	1150	0.82

* Coarse stripes, breaks in the glass ribbon.
** The decrease in the glass radiation coefficient in June 1997 was related to the fact that in May 1997 the temperature of the glass melt bottom layers in the region of the temperature maximum decreased by 18 – 20°C. This brought about a decrease in the temperature of formation of glass ribbons, breaking of ribbons, deterioration of glass quality, decrease in production volume.

abrupt changes from one type of material to another (Aktubinskii sand and local sand, GOST 5100–85 soda and GOST 10689–75 soda) and significant deviations in the actual content of Al_2O_3, Fe_2O_3, SiO_2, $Na_2O + K_2O$ in the chemical composition of the glass as compared to the rated values.

The glass melting conditions (glass temperature in the maximum zone of 950 ± 10°C, temperature of the cooling zone bottom of 1150 ± 10°C according to the bottom thermocouples; bulb temperature of 950 ± 10°C) were maintained due to the prescribed values of the iron oxide content (%): 0.021 ± 0.02 FeO, 25 ± 3 FeO : Fe_2O_3, 0.140 ± 0.020 Fe_2O_{3tot}.

The production of glass converted to 2 mm thickness in 1996 – 1997 increased to 17.5 thousand m^2 per day on average, versus 16.5 thousand m^2 per day in the last year of the previous operating period, i.e., production increased by 337 thousand m^2 per year.